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ABSTRACT

The psychometric integrity of selected items from the Mathematics Association of America (MAA) placement tests for college students was investigated. Two alternative and parallel versions of the test were developed (Form A and Form B) for this study. Data for 539 students seeking admission into an undergraduate mathematics curriculum at a private university in the southern United States who completed Form A of the MAA Placement Test were used, as well as data for two sets of the students (N=112; N=196) who completed a retesting using a parallel set of MAA items (Form B). Reliability coefficients for Forms A and B, item difficulty and discrimination, and test-retest reliability coefficients were computed. Results suggest that the measures performed reasonably well, although use of more items may be warranted to yield more psychometrically defensible placement scores. The reliability coefficient for results on Form A suggests reasonable psychometric integrity, but that extreme caution is needed for subscale scores. Subscales on the second version (Form B) also must be interpreted with caution. Two tables summarize item statistics. (SLD)

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LOCAL NORMS AND TEST CHARACTERISTICS FOR SELECTED FORMS OF THE M.A.A. PLACEMENT TEST

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ABSTRACT

The psychometric integrity of selected items from the Mathematics Association of America (MAA) placement tests was investigated using data from 539 students, some of whom completed a retesting using a parallel set of MAA items. Reliability, item difficulty and discrimination, and test-retest reliability coefficients were computed. Results suggest that the measures perform reasonably well, although use of more items may be warranted to yield more psychometrically defensible placement scores.

Undergraduate mathematics departments across the country have found the placement tests developed by the Mathematical Association of America (MAA) (1984) to be useful in providing optimal instruction for students. These tests were developed for college students and can be used to place students in courses ranging from remedial programs through calculus. Several forms of each test are available, and test levels and forms can be combined in several ways. The tests have been developed by content experts.

However, as perceptively noted in the user's guide for the tests, "Any experimental administration of a proposed placement test should be done using a randomly representative population. This is important because an item analysis, like any other set of statistics, is as much a function of the student population as it is of the test itself" (MAA, 1984, p. 10). The present study was conducted to evaluate local norms for selected forms of these tests and item characteristics and test reliability.

Method

Two cohorts of subjects completed alternate forms of the MAA placement tests. The first cohort of subjects (n=539) consisted of all students seeking admission or potential admission into an undergraduate mathematics curriculum at a private university in the southern United States. These subjects completed a 50 item version of the placement test, designated Form A.

Form A consisted of 18 items measuring mastery of arithmetic skills, 20 items measuring mastery of algebra concepts, and 12 items measuring mastery of finite math. The 12 finite math items

were written by local university faculty and are not part of the MAA placement tests. The 18 Form A arithmetic items were selected from among those presented in MAA placement test A-SK/1A. The 20 algebra items were selected from among those presented in MAA placement test BA/2B.

One semester after the 579 subjects completed the Form A placement test, a subset of subjects enrolled in math courses on the basis of their Form A scores. These subjects completed the items on a Form B placement test appropriate for their particular math placement. Thus, 112 subjects completed 18 Form B placement items dealing with arithmetic skills. These 18 Form B items were drawn from MAA placement test A-SK/1B. The Form A and Form B items were selected to constitute parallel forms. Thus, each item in each form had a corresponding item in the alternate form. For example, the first item on both forms involved subtraction of two numbers followed by division of the result; the items differed only in terms of numerical values employed, not in terms of actual skills tested.

Form B also included a parallel form of the 20 algebra items. The 20 Form B items were selected from MAA placement test BA/2C. These items were completed by 196 subjects during their enrollment in the assigned algebra class.

Analysis

The present study was conducted to address three research questions. First, what are the reliability coefficients for scores of Forms A and B and on subscales of the measures? Second, what are the item characteristics of the two test forms? Third,

what are the test-retest coefficients for scores on the parallel arithmetic and algebra subtests?

Cronbach's alpha was computed for Form A data to address the study's first research question. The alpha coefficient for total scores on Form A for the 539 subjects was 0.83. Alpha coefficients for the arithementic, algebra, and finite math Form A subscales were 0.60, 0.82, and 0.47, respectively.

For Form B data for the 112 subjects who completed the 18 parallel Form B arithmetic items, the alpha coefficient was 0.74. For the Form B data from the 196 subjects who completed the parallel Form B algebra items, the corresponding statistic was 0.76.

The study's second research question involved item statistics for the two parallel test forms. Table 1 presents the items in each subtest and the source of each item, reported in the column headed "Ref". For example, Form A item 1 was item 8 within the source MAA A-SK/1A placement test. Form A item 1 was exactly parallel in form to Form B item 1, and Form B item 1 was item 8 within the source MAA A-SK/1B test.

INSERT TABLE 1 ABOUT HERE.

The Table 1 column headed p indicates the proportion of students who correctly answered each item. The column headed r reports the corrected item-to-total-score correlation coefficient, called a discrimination coefficient. For example, the discrimination coefficient for Form A item 1 was 0.02. This was the correlation between scores on item 1 ("0" or "1") with total scores on all other 49 items ("0" through "49", inclusive).

The discrimination coefficients for Form B were computed separately for each test subscale, since these forms were completed by different subject subsets.

The study's third research question involved the test-retest reliability of scores across administration of parallel forms. Table 2 presents these coefficients for selected combinations of scores.

INSERT TABLE 2 ABOUT HERE.

Discussion

The present study was conducted to assess the psychometric integrity of scores generated from a subset of placement test items, most of which were selected from tests offered by the Mathematical Association of America (1984). The study investigated the reliability, item characteristics, and test-retest reliability of two parallel test forms.

The reliability coefficient for total scores on Form A of the test (0.83) suggests that this measure has reasonable psychometric integrity. However, reliability coefficients for the mathematics, algebra, and finite math subscales (respectively, 0.60, 0.82, and 0.47) suggest that subscale scores must be interpreted with extreme caution. The alpha coefficients for the parallel Form B arithmetic items (0.74) and for the parallel Form B algebra items (0.76) suggests that scores on these subscales also must be interpreted with some caution.

It is not terribly surprising that the finite math subscale was not very reliable. High scores on these items would suggest

extraordinary advanced placement, so the variability of scores on this item subset should be constrained. Furthermore, this subscale consists of only 12 items. However, it is somewhat more troubling that scores on the 18 arithmetic items do not tend to yield more reliable scores.

The item statistics presented in Table 1 do suggest that the finite math items are uniformly more difficult, as indicated by the smaller P values for these items. It is encouraging that the item difficulty values for matched items across parallel forms do tend to be comparable, suggesting that the items are reasonable matches.

Almost all the items have positive item discrimination coefficients, as reported in Table 1. This suggests that the primary cause of suppressed reliability coefficients may involve the use of too few items on the placement tests, rather than on the use of bad items per se.

The test-retest reliability coefficients across parallel forms administration, reported in Table 2, are somewhat troubling. Again, the algebra items yield a more favorable result (r=.54) than do the arithmetic items (r=.24).

Overall, the results suggest that the MAA placement items constitute a reasonable item core for assigning students to instructional levels. However, more items may be needed, particularly on the arithmetic subscales, in order to be assured of equitable placement decisions.

Reference

Mathematical Association of America. (1984). User's guide: The placement test program of the Mathematical Association of America (3rd ed.). Washington, DC: Author.

Table 1
Item Statistics for Two Test Forms

Form A				Form B			
Item	Ref	P	r	Item	Ref	P	r
Arithmetic							
1	8	.95	.02	1	8*	.83	.39
2	10	.86	.37	2	10	.78	.52
3	11	.76	.23	5	13	.55	.19
4	12	.95	.17	4	12*	.81	.39
5	13	.77	.42	3	11	.58	.28
6	14	.57	.29	6	14	.32	.27
7	15	.66	.31	9	18	.32	.19
8	17	.88	.25	8	17	.70	.51
9	18	.91	.28	7	15	.72	.41
10	19	.90	.12	11	19	.80	.48
11	20	.90	.26	12	20	.69	.50
12	21	.65	.09	13	21	.40	.13
13	22	.69	.17	14	22	.36	.18
14	23	.85	.27	17	25	.59	.43
15	24	.65	.15	16	24	.46	.22
16	25	.37	.17	15	23	.23	.19
17	26	.72	.23	10	27	.57	.30
18	27	.87	.32	18	26	.64	.25
Algebra							
19	2	.71	.42	21	4	.66	.48
20	3	.79	.44	22	5	.70	.40
21	4	.87	.34	19	2	.67	.29
22	5	.52	.45	20	3	.44	.33
23	7	.71	.43	23	8	.73	.42
24	10	.87	.40	24	10	.89	.38
25	11	.79	.27	25	11	.82	.15
26	13	.60	.50	26	13	.50	.38
27	14	.70	.46	28	15	.64	.27
28	15	.37	.40	27	14	.26	.34
29	16	.74	.27	30	17	.65	.35
30	17	.45	.39	31	18	.30	.25
31	18	.59	.44	29	16	.44	.41
32	19	.36	.37	32	19	.28	.36
33	20	.63	.48	33	20	.59	.27
34	21	.52	.46	35	24	.44	.43
35	22	.68	.38	38	22	.73	.26
36	23	.27	.28	34	23	.21	.30
37	24	.58	.10	37	21	.40	.16
38	25	.35	.25	36	25	.43	.21
Finite Math							
39		.35	.36				
40		.27	.28				
41		.29	.12				
42		.27	-.03				
43		.16	.08				
44		.12	-.02				

45	.30	.20		
46	.39	.31		
47	.31	.15		
48	.33	.03		
49	.26	.18		
50	.68	.23		
Mean	.594	.270	.556	.322
SD	.234	.137	.188	.108

Note. "*" designates two Form B items for which slight changes in notation were made in the source MAA items.

Table 2
Test-Retest Reliability Across Parallel Test Administrations

	Form A			
Form B	Arithmetic	Algebra	Finite Math	TOTAL
Arithmetic	.24	.37	.10	.38
Algebra	.27	.54	.18	.53